RESEARCH DEPARTMENT

The performance of certain television receivers designed for the 525/60 standard when operated from a 50c/s mains supply

REPORT No. T-119

1963/56

THE BRITISH BROADCASTING CORPORATION
ENGINEERING DIVISION

RESEARCH DEPARTMENT

THE PERFORMANCE OF CERTAIN TELEVISION RECEIVERS DESIGNED FOR THE 525/60 STANDARD WHEN OPERATED FROM A 50 c/s MAINS SUPPLY

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G.C. Wilkinson

(D. Maurice)

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SUMMARY

This report describes subjective tests on the performance of three domestic receivers, all designed to operate from either 50 or 60 c/s power supplies while displaying 525-line, 60 field-per-second television pictures; the tests and measurements were based upon a technique described previously.[1] The test results show that, when operating from 50 c/s power, the standard of performance was satisfactory only in the case of the largest and most expensive receiver.

1. INTRODUCTION

North America shares a common language with Great Britain and there exist, therefore, opportunities for the exchange of news and entertainment programmes between the two countries. Until recently, North American and British television programmes were exchanged only in the form of film recordings, and the fact that different scanning standards are used in the two areas did not pose a problem. With the advent of television tape-recording and the introduction of communication satellites, programmes are now exchanged in the form of video signals which must be standards-converted before transmission by the receiving network. If standards conversion could be avoided, the technical quality of the exchanged programmes would be improved very substantially and, in particular, the exchange of colour programmes would be greatly facilitated.

The possibility of avoiding the use of standards conversion is not as impracticable as it might appear, since the horizontal-scanning frequency of the North American (525-line) television system is almost the same as that of the 625-line European standard and it has been suggested that, by incorporating dual-standard field-scan circuits, future receivers would be capable of displaying pictures of both standards.

Previous work[1] has shown that receivers can be commercially produced which will display pictures substantially free from any interference effects due to their own mains supply - albeit at a slightly increased cost.

Such receivers must be capable of operating satisfactorily with a mains-supply frequency substantially different from the received field frequency. The two major defects likely to prevent satisfactory operation in these circumstances are flicker and picture 'wobble'.[2]

Flicker occurs when the potentials supplied to the cathode-ray tube (c.r.t.) electrodes contain components at the supply frequency; these, in turn, result from inadequate smoothing of the H.T. supply. Wobble is usually caused by hum in the deflection oscillators or in the deflection output circuits. Another form of wobble is caused by magnetic fields, due to chokes and transformers in the power-supply section of the receiver, influencing the c.r.t. beam position in a manner that varies over the screen.

The work described in this report was carried out in order to assess the standards of performance attained by three domestic receivers, designed and built by three separate manufacturers, which could provide an indication of the standard of receiver performance that may be expected if dual-standard operation (625/50 and 525/60) were adopted in this country.

2. THE RECEIVERS

Receiver A

This was described as a 'De Luxe Hi-Fi receiver' and used a 21-inch (53 cm) 110° c.r.t. having an unusually small scanning spot over the whole picture area. It was tunable throughout television Bands I and III and was designed to operate on the 525-line, 60 field-per-second standard; the inter-carrier system was used for sound reception. The displayed picture was of good commercial quality.

The cabinet of this receiver was very large compared to most of those used for currently produced receivers, being 30-inch × 20-inch × 18-inch (76·5 cm × 51 cm × 45 cm); this enabled the mains transformer and H.T. smoothing choke to be placed well away from the c.r.t. No further effort appeared to have been made to reduce the effect of the fields from these components. A single 'π' section filter was used to smooth the full-wave rectified H.T. supply to the main deflection-circuits, whilst the earlier stages, having a lower consumption, were supplied through additional resistance-capacity smoothing. The receiver was capable of being operated from mains supplies of 90 to 110 V a.c. only, and the valve heaters were fed with 6·3 V a.c. from the mains transformer.

Receiver B

This was a completely portable transistorized television receiver that incorporated an 8-inch (20 cm) c.r.t. having a 90° deflection angle. It was tunable to all the Band I and III transmission channels, was designed to operate at 525 lines, 60 fields-per-second and used the inter-carrier sound system. The receiver could be powered either from its internal 12 V battery or from a 100 V a.c. mains supply that was used to provide 12 V d.c. by means of a transformer, a rectifier and a single 'π' section smoothing filter consisting of a choke and two 4,000 μF capacitors.

The receiver was very compact, having the dimensions 8 inch × 7 inch × 9 inch (21 cm × 18 cm × 23 cm), and the mains transformer and choke were located very close to the neck of the c.r.t.

Receiver C

This was a 12-channel receiver, employing a 17 inch (43 cm) c.r.t. having a 110° deflection angle. Again, the inter-carrier principle of sound reception was used. The receiver was designed for operation from either 110 V or 240 V, a.c. or d.c. mains supply. For 240 V operation the valve heaters were connected in series; however, for 110 V operation, the two halves of the heater chain were paralleled. Half-wave, voltage-doubling rectification was employed together with two stages of H.T. smoothing. The H.T. chokes had been carefully placed and oriented in order to keep stray magnetic fields in the region of the c.r.t. to a minimum.

3. SUBJECTIVE TESTS

3.1. Experimental Procedure

Skilled observers were asked to grade the picture displayed by each receiver in terms of picture wobble and flicker, according to the standard scale of visibility, viz:

1. Imperceptible
2. Just perceptible
3. Perceptible but not disturbing
4. Slightly disturbing
5. Very disturbing
6. Unusable

Each receiver was viewed at a distance of five times the picture height and, in order to obviate comparative assessment of the three receivers, the receivers were used one at a time, with a day or two between tests. It had been noted in the previous work[1] that the subjective rating of asynchronous effects was not greatly influenced by the subject matter of the picture and, therefore, the only picture used throughout the tests was Test Card 'C'. The observers were also shown a plain raster produced by a video signal corresponding to 50% of white level so that flicker could be observed with less difficulty on the small screen of Receiver B.

The 525-line, 60 field-per-second video signal was generated by a flying-spot slide-scanner and then applied as negative modulation to a carrier having a frequency of about 186 Mc/s (a channel available on the tuners of all three receivers). All the transmission equipment was powered by a 60 c/s mains supply and a 50 c/s supply was used as the mains supply for the receiver under test.

The following supply conditions were used in the series of tests:

Test (a) Receiver A; 110 V, 50 c/s supply

Test (b) Receiver B; 100 V, 50 c/s supply

Test (c) Receiver C; 110 V, 50 c/s supply

Test (d) Receiver B; d.c. internal battery supply

Test (e) Receiver C; 240 V, 50 c/s supply

During the tests all receivers were operated at full working temperature, because previous experiments showed that some deterioration of performance can become apparent during the warming-up period.

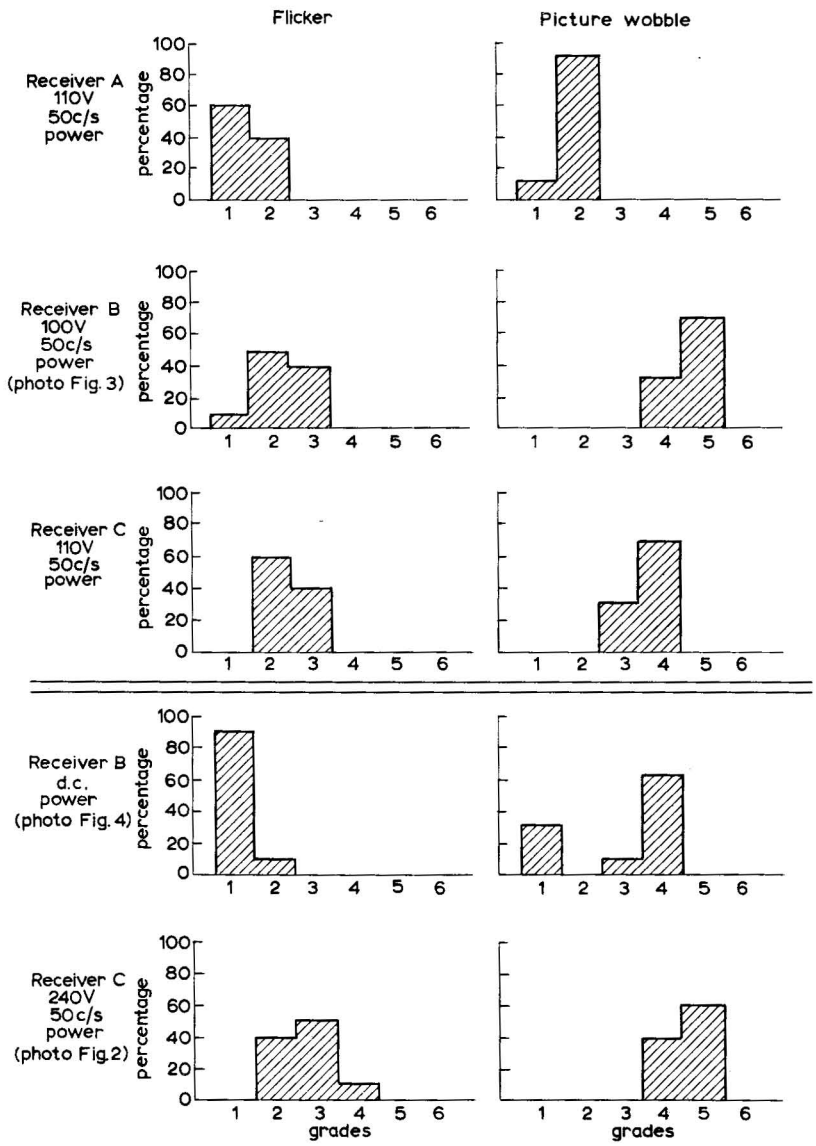

Fig. 1 - Histograms showing results of subjective tests

3.2. Results of Tests

The histograms of Fig. 1 show the results of the subjective tests, the first three tests being made under similar supply conditions. As regards both defects, Receiver A undoubtedly gave the best results, the flicker and picture wobble being graded not worse than 'just perceptible'. As regards picture wobble, the impairments shown by Receivers B and C were graded in the 'disturbing' region, Receiver B being one whole grade worse than Receiver C when both were powered from 100 V or 110 V, 50 c/s, mains. The poor result for Receiver B may have been partly due to unsatisfactory horizontal synchronization; this will be referred to later.

Fig. 2 shows the image displayed by one of the receivers when a stroboscopic technique was employed so as to permit the picture wobble to be photographed. By looking along the vertical white line in the black area at the left of the centre circle the amount of horizontal picture wobble displayed by the receiver can easily be discerned.

The uneven line spacing of the raster displayed by Receiver B, shown in the photograph of Fig. 3, indicates that the wobble was mainly in the vertical direction; this was graded 4 and 5 in the subjective tests.

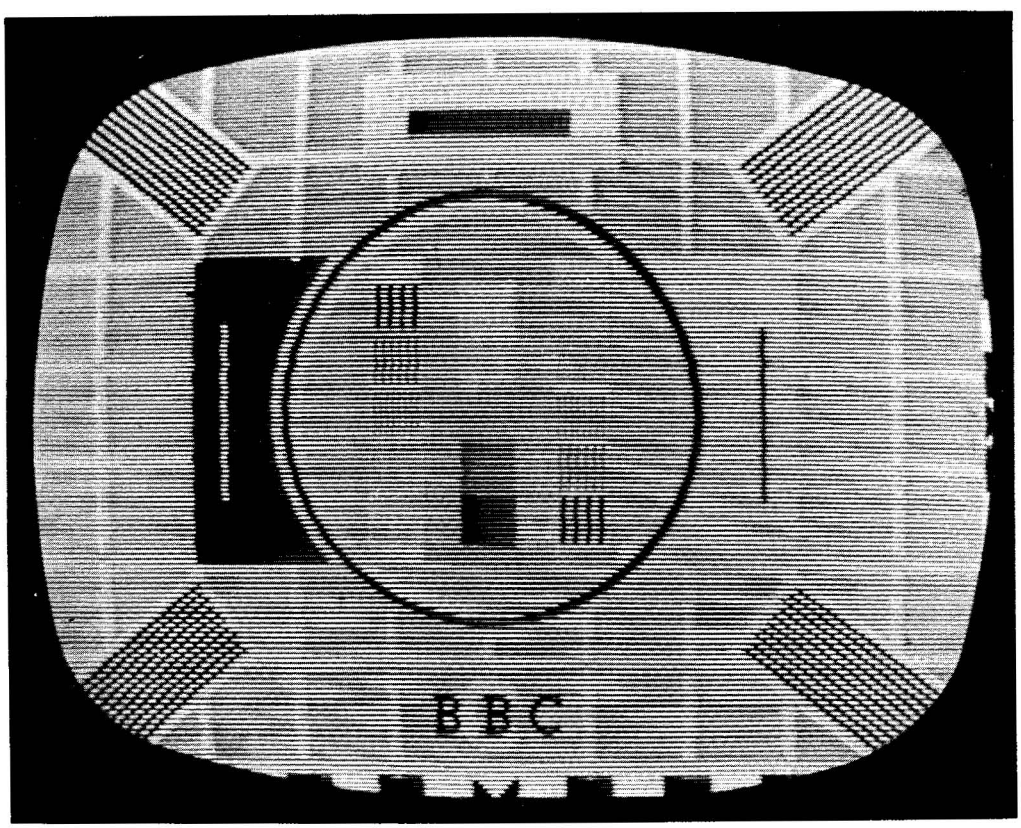

Fig. 2 - Receiver C. 240 V a.c., 50 c/s. Photograph of picture displayed, taken by the method used in Reference 1

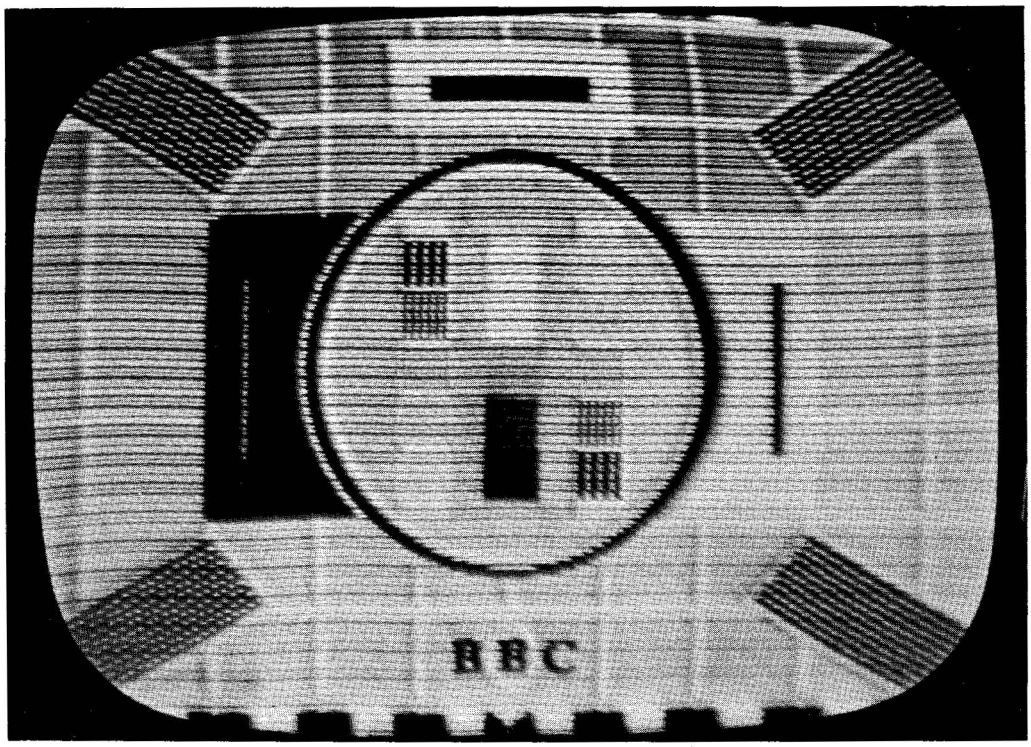

Fig. 3 - Receiver B. 100 V a.c., 50 c/s. Photograph of picture displayed, taken by the method used in Reference 1

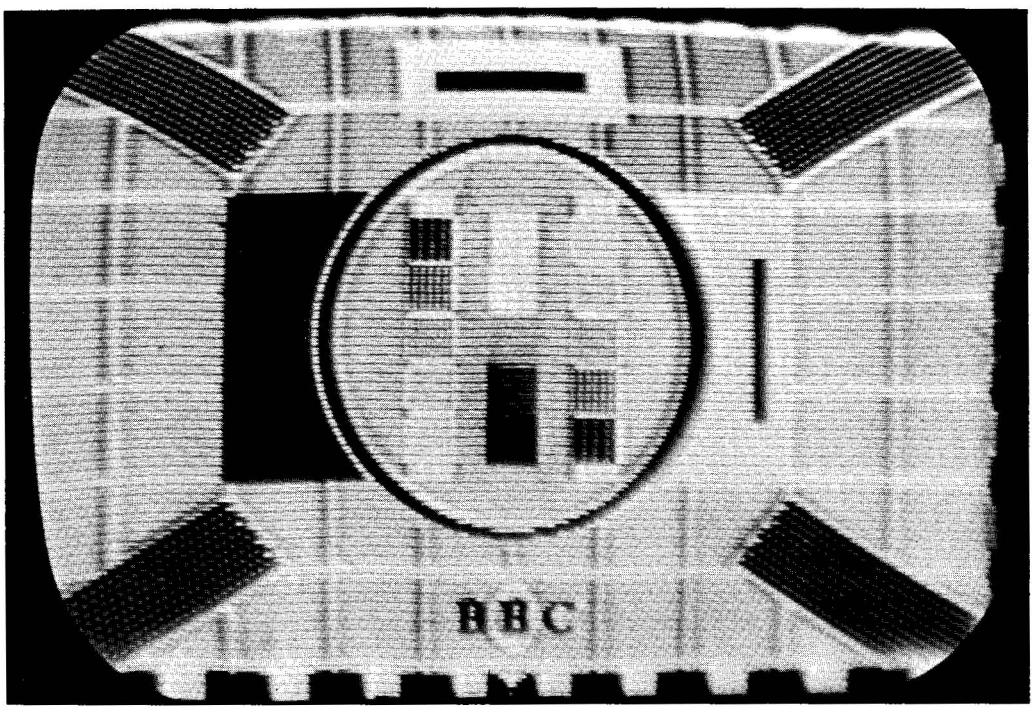

Fig. 4 - Receiver B. d.c. power. Photograph of picture displayed, taken by the method used in Reference 1

The photograph of Fig. 4 shows the picture displayed by Receiver B when powered by its batteries; there is no evidence of any 10 c/s wobble. However, the subjective assessment of picture wobble under these conditions resulted in grades other than 'imperceptible'. This result was unexpected and investigation showed that the picture on this receiver was subject to jitter originating in the line-synchronizing circuits. This defect in synchronization was not consistent, sometimes being 'imperceptible', but more frequently producing a random shuddering of the picture which resulted in a grading of 'slightly disturbing'.

The results, given in Fig. 1, for Receiver C showed that wobble was about one grade worse when the receiver was powered from 240 V a.c. than when it was powered by a 110 V a.c. mains supply.

In an attempt to correlate the subjective assessment of wobble with its actual value in terms of subtended angle at the observer's eye, the wobble displayed by all three receivers was photographed and its magnitude measured by means of a travelling microscope. The results are plotted in the graph of Fig. 5 and were derived from the subjective assessments and measured performances of all three receivers.

It is interesting to note that under the viewing conditions of these tests, one picture element subtended about 1·8 minutes of arc at the observer's eye, so that the smallest perceptible amount of wobble, about 21 seconds of arc, was equivalent to 0·2 picture elements. Normal visual acuity is quoted as being between 30 seconds and one minute of arc, and vernier acuity is given as 2 or 3 seconds of arc, so the figure of 21 seconds of arc lies somewhere between the limits of normal and vernier acuity.[3,4]

Referring again to Fig. 1, the flicker performance of Receiver A was given the best rating, that of Receiver B the next and Receiver C the poorest. Receivers A and B showed flicker at 20 c/s since their H.T. supplies were derived from full-wave rectification of the supply whilst Receiver C used half-wave rectification and hence showed flicker at 10 c/s,* so that the flicker on Receiver C would be far more visible than that shown on the other two receivers.

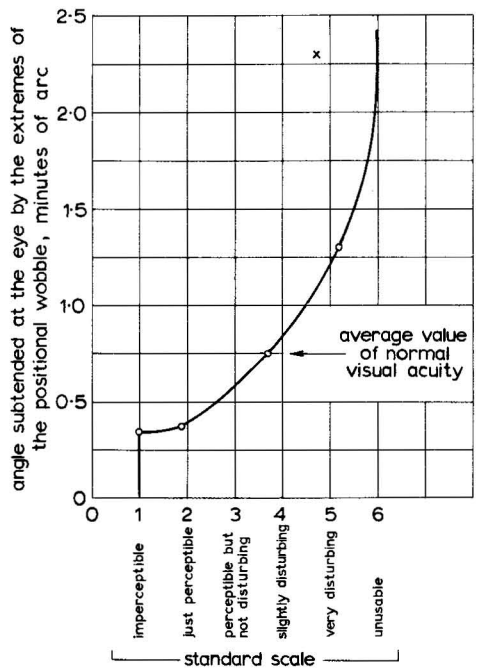

Fig. 5 - Graph referring subtended angles of horizontal movement to the standard subjective scale

(N.B.) The odd point indicated (x) has been obtained from the results of Receiver B. From the photograph of Fig. 3 most of the movement is seen to be in the vertical direction and this point has been calculated from the vector sum of the two movements.

* 60 field-per-second television disturbed by 50 c/s ripple completes one full stroboscopic cycle in 1/10th second, during which time six fields have been displayed and five cycles of ripple have occurred. 60 field-per-second television disturbed by 100 c/s ripple (due to full-wave rectification of the 50 c/s supply) completes one full stroboscopic cycle in 1/20th second, during which time three fields have been displayed and five cycles of ripple have occurred. In the former case a point in the picture therefore flickers at 10 c/s and, in the latter, at 20 c/s.

3.3. Discussion of Results

Receiver A, the one which performed satisfactorily as an 'asynchronous' receiver, was housed in a large cabinet, thus permitting components producing magnetic fields to be placed at a distance from the c.r.t. It also used a parallel-connected valve heater chain, with all heaters operated from 6·3 V, and full-wave rectification of the H.T. supply. These factors undoubtedly added to the cost, but at the same time contributed to the receiver's good performance.

Receiver B was contained within a very small cabinet and suffered greatly from the effects of magnetic fields that influenced the c.r.t. beam; it would have been very difficult to avoid these effects in such a small volume. This receiver, as regards operation from a 50 c/s mains supply, was regarded as unusable.

Receiver C was an a.c./d.c. model, incorporating a series-heater chain and half-wave rectification for the H.T. supply; both items mitigated against good asynchronous operation. However, it would be possible to improve the performance of this receiver by the methods outlined in Reference 1.

4. CONCLUSIONS

All three receivers showed pictures having a degree of flicker at, or near, the threshold of visibility and, therefore, it would appear easy to achieve a flicker-free picture using an inexpensive domestic design.

It seems more difficult to design receivers to give wobble-free pictures when working asynchronously. One of the models, Receiver A (the de-luxe model selling at about £150) gave a satisfactory result but the other two were poor.

The difficulty of making a receiver that is free of wobble stems from the exceedingly small picture movements that can be perceived by the human eye (0·2 picture elements).

From these experiments, and earlier work, it has been shown that domestic television receivers can display satisfactory 60 field-per-second television pictures when operated from 50 c/s mains. However, some increase in cost is inevitable as special precautions must be taken in order to avoid unwanted magnetic fields around the c.r.t., high a.c. heater-to-cathode voltages, and H.T. line ripple. These precautions, together with the special field-scan arrangements necessary, might result in the cost of a satisfactory dual-standard receiver being from £5 to £10 higher than that of the single-standard set.

5. REFERENCES

1. 'The Reception of 60 Field Television with 50 c/s Power', Research Department Technical Memorandum No. T-1055.

2. 'The Visibility of Certain Positional and Brightness Disturbances on Television Pictures', Research Department Technical Memorandum No. T-1050.

3. Fink, D.G., 'Principles of Television Engineering', 1st Edition, Chapter II, Section 7, p. 32.

4. 'A Note on the Definition of Visual Acuity', Research Department Report No. T-036, Serial No. 1953/1.

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CONFIDENTIAL ADDENDUM

RESEARCH DEPARTMENT - BRITISH BROADCASTING CORPORATION

Report No. T-119 November 1963

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RECEIVER A

'Maria Sonu' TX 240. Price about £150. By Hitachi Ltd., Tokyo, Japan.

RECEIVER B

'Transistor TV 8 - 301'. Price about £38. By Sony Corporation, Tokyo, Japan.

RECEIVER C

'X 617/F'. Price about £40. By Pye Ltd., Cambridge, England.